

Advanced in Algorithms, Security, and Systems for ICT Convergence

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Abstract

Future information and communication technology (ICT) is constantly evolving and converging in diverse fields depending on the wireless environment, and the trend is being further developed to increase the speed of wireless networks. Future ICT is needed in many areas such as active senior & solo-economy, hyper-connected society, intelligent machine, industrial boundary collapse, secured self, and the sharing economy. However, a lot of research is needed to solve problems such as machine learning, security, prediction, unmanned technology, etc. Therefore, this paper describes some technologies developed in the areas of blockchain, fault diagnosis, security, agricultural ICT, cloud, life safety and care, and climate monitoring in order to provide insights into the future paradigm.

Keywords

Advanced Technology, ICT Convergence, Fault Diagnosis, Security

1. Introduction

Software development has led to a period of significant social transformation. The current era is characterized by constantly changing technologies and environments. Therefore, research and implementation strategies should be adopted by the IT environment to prepare for future changes, regardless of the causes and speed of change.

Recent changes in information and communication technology (ICT) convergence can be summarized as big flows, such as blockchain, fault diagnosis, security, agricultural ICT, cloud, and life safety and care. In the wireless field, in particular, many technologies, such as data transmission technology and battery technology for wireless devices, are required.

This paper describes advanced forestry algorithms, such as a random forest algorithm for increasing the accuracy in detecting access points (APs), an alternative state estimation filtering algorithm that selectively uses two types of estimation filters with different memory structures, and a location search algorithm that improves the Fang algorithm.

This paper also summarizes the following technologies: a technology that considers the balance between the performance and security of a blockchain-based system; a spatial object expression

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technology for expressing 3D space by registering multiple views of images; a wireless power transfer limit (WPTL) algorithm for reducing damage to the wireless charging receiver of a smartphone; and a multigrain angle technology for automating plant leaf classification search by using an image processing technology. As interest in non-face-to-face (online) education has increased recently due to the coronavirus disease 2019 (COVID-19) pandemic, the functions of learning management systems (LMSs) are also developing. The LMS summarized in this paper proposes the architecture of a ubiquitous learning system based on the Experience API (xAPI).

2. Advanced in Algorithms, Security, and Systems for ICT Convergence

Wang and Cao [1] proposed a fault diagnosis method for a high-precision cost-referenced particle filter (CRPF) in a complex nonlinear system under complex noise conditions. The authors introduced an intelligent optimization operation of the CRPF algorithm and analyzed the noise correction capability of this algorithm under conditions of strong noise interference, and then determined the fault detection accuracy in complex nonlinear systems in other noisy environments.

Evil twin APs imitate the addresses of the service set identifier (SSID) and media access control (MAC) of authorized APs to facilitate message forgery and eavesdropping. Seo et al. [2] proposed a method of detecting evil twin APs by using multifunction-based machine learning classification algorithms in wireless networks, with clock skew, signal strength, channel and duration as the features. These features were applied to several machine learning classification algorithms, including logistic regression, naive Bayes (NB), k -nearest neighbors (k -NN), support vector machine (SVM), and random forest, to increase the accuracy of detection. Through experiments, the authors confirmed that the proposed method uses random forest algorithms to provide a high degree of accuracy in detecting evil twin APs.

Zhang et al. [3] proposed a fire smoke detection algorithm for videos based on wavelet energy slope fittings that can prevent false fire alarms under the influence of clouds, fog, and moving objects. This algorithm uses the diffusion properties of smoke movement and provides smoke alarms based on changes in wavelet energy in an image within a specified time. The authors confirmed that they can detect smoke during the early stages of a fire accident by removing the obstacles around them that affect fire judgment.

Sun et al. [4] proposed and implemented the architecture of a ubiquitous learning system based on the Experience API (xAPI). The system integrates hands-on APIs to provide a learner-oriented data collection and learning process recording model. By addressing the shortcomings of the existing Shareable Content Object Reference Model (SCORM), Learning Record Store (LRS)-based storage and acquisition were realized. In addition, the learning record model was established from the horizontal and vertical perspectives, providing the analysis results of a learner's learning behavior and activities and confirming a learner's interests and quality improvement through the students' feedback.

Kim [5] studied alternative state estimation filtering algorithms designed for continuous-time systems with control inputs and noises by selectively operating two types of estimation filters with different memory structures. Estimates of infinite memory structure (IMS) filters operating in certain continuous-time systems and finite memory structure (FMS) filters operating in temporarily uncertain continuous-time systems are optionally used to obtain useful estimates based on their uncertain existence. The author verified the proposed algorithm through a simulation in a continuous-time aircraft engine system.

Song et al. [6] proposed an iris-based cryptographic character authentication system based on fully homogeneous encryption using the Fan–Vercauteren (FV) method of identification through biometric recognition. An existing biometric authentication system was analyzed and described, and a complete dynamic encryption system based on the iris function was designed and implemented using FV and Microsoft’s Simple Encrypted Arithmetic Library (SEAL). The authors conducted tests to validate the performance of the proposed system and to ensure that the requirements of the actual application scenarios were met.

Yang et al. [7] developed an ideal behavior recognition method based on the cascaded topic model in the behavioral monitoring scenes of several objects with complex correlations. The abnormal behavior recognition method decomposes complex behavior in a surveillance video in accordance with the spatiotemporal characteristics of behavior to simplify modeling and reflect the spatiotemporal context structure so as to effectively detect anomalous behavior. The authors verified the identification of various types of anomalous behavior and complex behavior anomalies through experiments.

Byun et al. [8] presented an unmanned automated system (robot) that recognizes the red color in color space and can harvest peppers. The robot thus proposed used the OpenCV library as an image processing module, and its control module controlled the DC motor and a step motor for harvesting peppers. The technology used in this study applied the convergence of ICT and agriculture as an alternative to addressing labor shortages in rural areas.

The Fang algorithm is a vibration target localization algorithm based on time difference of arrival (TDOA). He et al. [9] presented the Fang algorithm problem in the case of large delay estimation errors and proposed a 1D search location algorithm based on search variables in order to improve the real-time performance and accuracy of the target system. The authors introduced the concept of search into the algorithm and used the distance between the source and the sensor as a search variable. Target position search was implemented by changing variable search values on a 2D plane. The proposed algorithm was verified to achieve excellent speed and accuracy through a simulation.

Li et al. [10] proposed a preventive elderly health care service system by utilizing Bluetooth low energy (BLE) beacon-based identification and Internet of Things (IoT) technologies. The proposed system simplifies the user interface and the steps to enable family members, caregivers, and medical personnel to record the daily health care information of elderly people in a quick and convenient fashion. In accordance with statistics and system analysis, the developed system is recommended for use in analyzing future directions and trends in elderly care management.

Xu et al. [11] proposed a multi-granular angle technique method to automatically provide plant leaf classification and retrieval using computer technology and image processing techniques. They describe how the general practice of plant leaf classification includes several stages, including leaf image pre-processing, feature extraction/matching, and classifier design, among which feature extraction and classifier design are crucial components. The proposed method can describe approximate fine leaf information using multiple granular angle features, where each leaf contour is first divided into equal arc lengths under different particle sizes. Then, it is possible to derive three kinds of angle features of angle values, angle histogram, and angle ternary pattern under each subdivided partition of the leaf shape. This multi-granular angular feature captures both the local and global information of leaf contours and processes the dissimilarity calculation process of each pair of leaves under different particle sizes using simple illustrated block metrics in the leaf matching step. To evaluate performance, plant leaf classification and search based on two leaf image databases, the Swedish leaf database and the Flavia

leaf database, were conducted, and the proposed method consequently showed promising classification and search performance.

In order to protect the wireless charging receiver from electric shock originating from a vehicle's wireless charging system, Park and Hwang [12] measured various scenarios by implementing the actual vehicle wireless charging system based on the scenario specified in the WPC standard. When charging a smartphone using a wireless charging system in a vehicle, if the location of the smartphone deviates from the charging location of the wireless charging pad due to the external impacts of the vehicle, such as quick breaking, swerving, or bumping on the road, etc., the wireless charging receiver may cause damage to the receiver circuit due to electrical shock. The authors proved these possibilities through experiments. To reduce the damages to the wireless charging receiver of the smartphone, the author proposed a wireless power transfer limit (WPTL) algorithm to limit the damage to the receiving circuit by limiting the transmitter of the wireless charging system in vehicles. As a result of implementing the circuit diagram based on the algorithm and conducting experiments in an environment similar to the real world, the experimental results show the difference of voltage change between a receiver applied with WPTL and a receiver without WPTL.

Techniques such as LIDAR or multiple view registration of images can express a spatial object by generating a point cloud, which is a collection of points spread in three-dimensional space from data collected using a sensor. Wei et al. [13] conducted a study on a point cloud thinning model that can remove numerous redundant points from various collected spatial data while maintaining the characteristics of the points. In general, models with low complexity have low accuracy of point cloud thinning, and models with high complexity require more computation time to generate point clouds; therefore, the authors proposed a point cloud thinning algorithm suitable for small and medium-sized users who can solve these problems. To further simplify the complex classification indexing technique, the authors use 2D indexing to set up a planar linear array for the scanned point cloud and make it possible to construct a point cloud by determining whether to delete or keep the sample point of the scanned point cloud by placing a threshold on the difference between the distance and the height of the adjacent point. By performing these tasks until the point cloud process is completed, the point cloud could be configured faster and more accurately than the existing octree algorithm.

Rahmadika et al. [14] focused on the safety problems of the recent blockchain-based system due to propagation delay caused by the process of traversing all nodes of the distributed P2P network, and conducted a sophisticated review of the parameters related to the propagation time of the system. The authors illustrated the most important information related to the block propagation time within the blockchain P2P architecture along with some other influential parameters and presented the effects of block size, consensus, and blockchain scalability, including the relationship of parameters. They analyzed and showed the influences of the block size by providing the relation graph between block size and time, and described how simply increasing the capacity in a block without proper analysis can affect the propagation time that sacrifices security in the blockchain system. The authors concluded that the enhancement of the performance of the decentralized blockchain in the P2P network topology requires a very articulated analysis since it is directly affected to its security. The trade-off between performance and security needs to be carefully considered before being applied in real-world applications.

Li et al. [15] attempted to analyze the emotions of comments from numerous online webcast reviews that occurred in real-time on webcasts, which constitute a growing real-time internet broadcast phenomenon. The webcast live barrage is defined as the real-time comments that occur in most online

broadcasts. Unlike actual social media comments or product reviews, the subject of a webcast barrage is very fragmented. In addition, in the case of real-time comments, there are many invalid comments that have to be removed in the preprocessing step, and in the case of a single word or a simple sentence, there is a problem in that it is difficult to understand the meaning. The authors tried to extract evaluation sentiment sentences and proposed a new approach to clustering the webcast live barrage of the same authors to solve the problem of scattering information about each opinion. The new approach included two sub-sub tasks, the first of which consisted in clustering the sentences of the same commenter and removing unusable sentences in the preprocessing phase of the data, while the second consisted in analyzing the emotions of the webcast live barrage by using a semi-supervised machine learning approach through the naive Bayes algorithm. Using the existing machine learning algorithms NB, SVM, and CRF, various experimental results were obtained using the proposed clustering. The results showed that the proposed clustering method can effectively categorize the emotions of a webcast live barrage.

Park and Park [16] proposed a smart dust environment system in which they focused on solving the network bottleneck and disconnection problem of devices that can provide reliable data transmission and connection of a large number of smart dust sensor devices. In order to solve the bottleneck and disconnection problem, a three-layer hierarchical smart dust monitoring system was constructed, including relay dust devices (RDD), which have higher computing and communication capabilities than general smart dust devices. In the proposed system, the authors established the threshold filtering phase and the integration filtering phase to reduce network traffic so as to be able to process a large amount of monitoring data and mitigate bottlenecks. In order to evaluate the effectiveness of the proposed system, the authors conducted a comparative analysis of the system with other systems using climate data obtained from approved portals. As a result, it was confirmed that the transmission processing time could be reduced by 49%–50% compared to other systems, while the maximum number of connectable devices could be increased by 16–32 times without affecting the system operation.

3. Conclusion

This issue features sixteen high-quality articles that have been subjected to a rigorous review process. This paper reviewed the technologies developed in various research fields, such as blockchain, fault diagnosis, security certification, agricultural ICT, cloud, life safety and care, and climate monitoring, in order to provide insights into the future paradigm. This paper also presents published articles on the following topics: contributions to theoretical research, including new techniques, concepts, or analyses; experience reports; experiments involving the implementation and application of new theories; and tutorials on state-of-the-art technologies related to ICT convergence.

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